EFFECT OF VARIED REST INTERVAL BETWEEN SETS OF RESISTANCE TRAINING ON STRENGTH, SELECTED BLOOD AND CARDIAC BIOMARKERS IN UNTRAINED MEN

by

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CONTENT

S.NO	DISCRIPTION	PAGE NO.
1.	Chapter 1: Introduction	1
2	Statement of the problem	6
3	Objectives of the problem	6
4	Hypothesis	7
5	Delimitation	7
6	Significance of the study	9
7	Chapter 2: Review of related literature	10
8	Chapter 3: Methodology	13
9	Selection of subjects	13
10	Administration of test	13
11	Collection of data	14
12	Expected outcome of the study	14
13	References	15

CHAPTER 1
INTRODUCTION

Resistance training is a modality of exercise that has grown in popularity over the past two decades, particularly for its role in improving athletic performance by increasing muscular strength, power and speed, hypertrophy, local muscular endurance, motor performance, balance, and coordination. Traditionally, resistance training was performed by few individuals (e.g., strength athletes and those who strived to gain muscle hypertrophy such as body builders). However, we now have a better understanding of the health-related benefits of resistance training; resistance training is now a popular form of exercise that is recommended by national health organizations such as the American College of Sports Medicine and the American Heart Association for most populations including adolescents, healthy adults, the elderly, and clinical populations (e.g., those individuals with cardiovascular disease, neuromuscular disease). The key factor to successful resistance training at any level of fitness or age is appropriate program design. Program design entails proper exercise instruction (e.g., technique, breathing, correct use of equipment), goal setting (so the program can target specific areas of interest), a method of evaluation of training progress toward training goals, the correct prescription of the acute program variables, and the inclusion of specific methods of progression targeting particular areas of muscular fitness. It is important that resistance training should be supervised by qualified professionals for the prevention of injury and for maximizing the health and performance benefits. In this article, we will review resistance training program design and the associated factors that need to be considered. In addition, we will consider progression during resistance training in relation to individual training status and goals, and will highlight some of the important concepts of progression recently recommended by the American College of Sports Medicine (Kraemer & Ratamess, 2004).

RESISTANCE TRAINING PROGRAM DESIGN

The resistance training program is a composite of acute variables that include: 1) muscle actions used, 2) resistance used, 3) volume (total number of sets and repetitions), 4) exercises selected and workout structure (e.g., the number of muscle groups trained), 5) the sequence of exercise performance, 6) rest intervals between sets, 7) repetition velocity, and 8) training

frequency (29,62). Altering one or several of these variables will affect the training stimuli and potentially favor conditions by which numerous ways exist to vary resistance training programs and maintain/increase participant motivation. Therefore, proper resistance exercise prescription involves manipulation of each variable specific to the targeted goals (Kraemer & Ratamess, 2004).

CHRONIC ADAPTATIONS AND THE REST INTERVAL BETWEEN SETS

Influence of Rest Interval Length on Muscular Strength and Power Adaptations:

For programmes targeting absolute strength and power development, the American College of Sports Medicine recommended 2- to 3-minute rest intervals between sets when performing multi-joint exercises and 1- to 2-minute rest intervals between sets for single-joint exercises. Longer rest intervals may allow for maximal voluntary activation of motor units and maintenance of training intensity. These recommendations were validated by Pincivero et al. for isokinetic-type training. Fifteen untrained men were divided into group 1 (40 seconds) and group 2 (160 seconds). One leg of each subject was assigned to a 4-week, 3-days-per-week isokinetic protocol that involved concentric knee extension and flexion muscle actions performed at 90°/sec. Changes in quadricep and hamstring function were evaluated with five repetitions performed at 60°/sec and 30 repetitions performed at 180°/sec. The 160-second rest group demonstrated significantly greater increases in peak torque, average power and total work at 180°/sec (Figueiredo et al., 2016).

When training for muscular strength with loads smaller than 90% of 1RM (up to 50%) for multiple sets, 3- to 5-minute rest intervals are necessary to maintain the number of repetitions performed per set within the prescribed zone without great reductions in training intensity. On the other hand, contrary to what was observed in most of the experiments concerning muscular strength, some evidence suggests that 1-minute intervals allowed for sufficient recovery during repeated 1RM attempts; however, from a psychological and physiological standpoint, thinclusion of 3- to 5-minute rest intervals might be safer and more reliable. The acute expression of muscular power was best maintained when including 3- or 5-minute rest intervals versus 1-minute rest intervals between sets. When the training goal is muscular hypertrophy, the combination of moderate-intensity sets with short intervals of 30–60 seconds might be the best alternative, due to higher acute increases of growth hormone, which can contribute to the hypertrophic effect.

EXERCISE ORDER AND WORKOUT STRUCTURE

The sequencing of exercises and number of muscle groups trained during a workout significantly affects the acute expression of muscular strength (97). For example, there are three basic workout structures: 1) total-body workouts, 2) upper/lower body split workouts, and 3) muscle group split routines. Total-body workouts involve performance of exercises stressing all major muscle groups (i.e., one to two exercises for each major muscle group). They are common among general fitness enthusiasts, athletes, and Olympic weightlifters. Upper/lower body split workouts involve performance of upper-body exercises during one workout and lower-body exercises during another. These are common among general fitness enthusiasts, athletes, power lifters, and body builders. Muscle group split routines involve performance of exercises for specific muscle groups during the same workout (e.g., a "chest/triceps" workout where all exercises for the chest are performed then all exercises for the triceps are performed). These types of workouts are most popular among body builders or individuals striving to maximize muscle hypertrophy. All three workout structures are effective for improving muscular fitness, and it appears that individual goals, time/frequency, and personal preferences often determines which type of work-out will be used. The major differences between these structures are the magnitude of specialization observed during each workout (i.e., three to four exercises for a specific muscle group may be performed during a muscle group split routine workout as opposed to one to two exercises for a muscle group in a total-body workout) and the amount of recovery between workouts (i.e., a major muscle group may be trained 1 to 2 wk for a split routine, 2 to 3wk for an upper/lower-body split, and 3 or more times per week for a total-body workout during most typical lifting programs) (Kraemer & Ratamess, 2004).

Planning and designing a resistance training program for muscular strength-related goals involves manipulation of program variables that include exercise selection, training volume, training intensity, movement velocity, and rest intervals (RIs). RIs are defined as the time dedicated to recovery between sets and exercises. RIs may affect metabolic responses, volume load, and hormonal levels. The duration of a RI must be sufficient to allow for replenishment of adenosine triphosphate and phosphocreatine, and for the removal of accumulated lactic acid.

Insufficient RI length may increase reliance on glycolytic energy production and affect metabolic buildup. Such events might compromise the ability to sustain repeated high-force

muscular contractions and may be suboptimal when training for muscular strength. While RI duration is a significant variable underlying gain in muscular strength, it has often been overlooked by both exercise practitioners and scientists(Grgic et al., 2018).

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Considerable evidence is accumulating from longitudinal studies (weeks in duration) that investigated muscular strength adaptations to different RI duration. However, the findings between studies seem to be equivocal. For instance, a study by Villanueva et al. involving resistance training naive participants found that a shorter duration RI (i.e., 1 min) may contribute to greater muscular strength gains as opposed to a longer RI duration (i.e., 4 min). Following 8 weeks of resistance training, the group that trained with short RIs achieved an 11 and a 10% greater increase in upper- and lower-body muscular strength than the group that trained with longer RIs, respectively.

Regular physical activity is a positive determinant of longevity and is associated with an improved cardiovascular risk . However, prescription of exercise may be complex. The

Paracelsus concept of dose-related toxic effects of drugs has been recently extended to sports , advocating the need to establish the 'dose' of exercise that might be even harmful, rather than protective. Vigorous exertion may in-turn transiently increase the risk of acute cardiac events in elite and non-elite athletes , of atrial fibrillation for endurance sports' practitioners , as well as of transient cardiovascular modifications and permanent remodeling in ultra-marathon , marathon, and half-marathon runners. The level of exercise to be recommended at different ages, in the presence of cardiovascular risk, and/or diagnosed cardiovascular disease is also under discussion . Exercise intensity may play a critical role as a potential noxious factor not only during races, but also during training sessions. In this perspective, the understanding of exercise-induced modifications in the neural mechanisms controlling the cardiovascular system might play an important role in tailoring the exercise dose for each individual. A shift towards a predominance of sympathetic modulation to the heart and vessels has been reported in endurance exercise. On the other hand, these modifications together with a decreased cardiac baroreflex sensitivity are independent risk factors for increased cardiac mortality after a myocardial infarction. It is therefore critical to assess whether or not athletes may exhibit a habitual exceeding cardiovascular sympathetic tone resulting from bouts of strenuous exercise that might theoretically increase their overall cardiovascular risk profile (Dalla Vecchia et al., 2019).

REST PERIODS

The need to rest between sets is often a frustrating requirement for people with limited time to train. However, adequate rest between sets is considered a crucial program variable for optimizing gains in strength and hypertrophy. The interset rest period allows the body to remove lactic acid, and replenish adenosine triphosphate and phosphocreatine—i.e. organic chemicals important for muscular contraction. Insufficient rest can result in a reduced capacity to maintain high muscular force throughout multiple sets and a lowered training volume load (load × repetitions× sets), which is considered important for improving both hypertrophy and strength. Common guidelines recommend a 3–5 min rest interval when training to maximize strength, a 1–2 min rest interval when the goal is hypertrophy, and a 30–60 s rest interval when the goal is muscular endurance. This advice is reflected in recent reviews, where it was concluded that rest intervals should vary from 2–5 min depending on whether the goal is hypertrophy or strength and power. However, a 2017 systematic review by Grgic et al.

encompassing 23 RCTs found evidence that short rest intervals (< 1 min) produced robust strength gains in both untrained and trained individuals (10 of the studies included trained populations) although less so than longer rest intervals. The review also found that 1–2 min rest is sufficient for maximizing muscular strength gains in untrained individuals. It also is interesting to note that some studies have found that trained individuals can build up tolerance for short rest intervals. Two RCTs utilizing 8 weeks of training with 8–12 RM suggested that, compared to using a constant rest period of 2 min, training with a progressively decreasing rest time (2 min reduced to 30 s) produced a similar increase in 1RM strength in both the bench press and squat, as well as isokinetic peak torque in the knee extensors and flexors. However, more research is needed to make clear recommendations regarding building tolerance for short rest intervals. Based on most evidence, we advise untrained individuals to schedule 1–2 min rest intervals and trained individuals ≥ 2 min rest intervals. In the following section, we present training techniques that provide the ability to limit the amount of passive rest without significantly compromising results.

On the basis of literature review it is clear that all types of rest interavals would increase muscular gain however the gap remains in about the effect of different rest intervals between sets on cardiac health. According from suggestions from different physicians and researchers personal interest, variables of this study have been finalized.

STATEMENT OF THE PROBLEM

The purpose of the study is to examine the effect of varied rest interval between sets of resistance training on strength, selected blood and cardiac biomarkers in untrained men.

OBJECTIVES OF THE STUDY

The objectives of the study are to find out:

- Effect of varied rest interval between sets of resistance training on strength in untrained men.
- Effect of varied rest interval between sets of resistance training on selected blood biomarkers in untrained men.

- Effect of varied rest interval between sets of resistance training on selected cardiac biomarkers in untrained men.
- Compare the effect of varied rest interval between sets of resistance training on strength, selected blood and cardiac biomarkers in untrained men.

HYPOTHESIS

1. There may be significant effect of varied rest interval between sets of resistance training on strength in untrained men.
2. There may be significant effect of varied rest interval between sets of resistance training on selected blood biomarkers in untrained men.
3. There may be significant effect of varied rest interval between sets of resistance training on cardiac biomarkers in untrained men.
4. Further it is hypothesized that there may be significant effect in liver functioning test of recreational athlete and sedentary individuals.
5. There may be significant effect of varied rest interval between sets of resistance training among three different groups of untrained men.

DELIMITATIONS

- The study will be delimited to 45 young untrained men with 15 participants in each grouyp.
- The study will be delimited to men with age ranging from 18-35 years.
- The study is further delimited to untrained men of Fitness World The Elite Gym, Ajmer.
- The delimited independent variables and dependent variables of the study will be:

Independent variable: three groups will be taken for the study.

i. Group A: shorter rest interval between sets of RT.
ii. Group B: longer rest interval between sets of RT.
iii. Control Group

Dependent variable:

- Test for strength (1 RM)
- Selected blood biomarkers
- Selected cardiac biomarkers
- Liver functioning test

- The study is restricted to 4 days/week for a total of 8 weeks of training.
- The study is further limited to fixed number of exercises, repetition and sets.

SIGNIFICANCE OF THE STUDY

- The finding of the present study may have significant contribution towards the refinement in making training protocol.
- This study may be helpful to the recreational athletes and personal trainers to evaluate performance.
- The study may provide knowledge to the individuals about the relation of training volume with repetition, frequency and intensity.
- This study may provide a basic concept for designing the training plan.
- Similar study may be undertaken with athletes of different sports understand the scientific principles involved in it.
- Similar study may be replicated for young female untrained group and in different age groups.

CHAPTER- II

REVIEW OF RELATED LITERATURE

The research scholar has gone through various studies available in shodhganga, Google Scholar, PubMed, Elsevier and other Journals. The relevant study from various sources which the investigation came across is enumerated below:

Ruth E Ashton (2017) examined the effects of short-term, medium-term and long-term resistance exercise training (RET) on measures of cardiometabolic health in adults. Eligibility criteria for selecting studies Randomised controlled trials published in English comparing RET≥2 weeks in duration with a nonexercising control or usual care group. Participants were non-athletic and aged ≥18 years. A total of 173 trials were included. Mediumterm and long-term RET reduced systolic blood pressure (−4.02 (95% CI −5.92 to −2.11) mm Hg, p<0.0001 and −5.08 (−10.04 to –0.13) mm Hg, p=0.04, respectively) and diastolic blood pressure (−1.73 (−2.88 to –0.57) mm Hg, p=0.003 and −4.93 (−8.58 to –1.28) mm Hg, p=0.008, respectively) versus control. Medium-term RET elicited reductions in fasted insulin and insulin resistance (−0.59 (−0.97 to –0.21) μU/mL, p=0.002 and −1.22 (−2.29 to –0.15) μU/mL, p=0.02, respectively). The effects were greater in those with elevated cardiometabolic risk or disease compared with younger healthy adults. The quality of evidence was low or very low for all outcomes. There was limited evidence of adverse events. RET may be effective for inducing improvements in cardio metabolic health outcomes in healthy adults and those with an adverse cardio metabolic risk profile.

Jozo Grgic (2017) conducted a systemic review of the effects of Rest Interval Duration in Resistance Training on Measures of Muscular Strength. Objective of the study were: to aggregate findings and interpret the studies that assessed chronic muscular strength adaptations to resistance training interventions involving different RI durations, and (ii) to provide evidence-based recommendations for exercise practitioners and athletes. The review was performed according to the PRISMA guidelines with a literature search encompassing five databases. Methodological quality of the studies was evaluated using a modified version of the Downs and Black checklist. Twenty-three studies comprising a total of 491 participants (413 males and 78 females) were found to meet the inclusion criteria. All studies were

classified as being of good to moderate methodological quality; none of the studies were of poor methodological quality.

Julius Fink et. al. (2016) investigated the effects of volume-matched resistance training (RT) with different training loads and rest intervals on acute responses and long-term muscle and strength gains. Ten subjects trained with short rest (30 s) combined with low load (20 RM) (SL) and ten subjects performed the same protocol with long rest (3 min) and high load (8 RM) (LH). Cross-sectional area (CSA) of the upper arm was measured by magnetic resonance imaging before and after 8 weeks of training. Acute stress markers such as growth hormone (GH) and muscle thickness (MT) changes have been assessed pre and post a single RT session. Only the SL group demonstrated significant increases in GH (770420 -1183349%, P<005) and MT (352 - 169%, P<005) immediately after training. After 8 weeks, the arm CSA s in both groups significantly increased [SL: 993 - 486% (P<0001), LH: 473 - 301% (P<005)]. No significant correlation between acute GH elevations and CSA increases could be observed. We conclude that short rest combined with low-load training might induce a high amount of metabolic stress ultimately leading to improved muscle hypertrophy while long rest with high-load training might lead to superior strength increases. Acute GH increases seem not to be directly correlated with muscle hypertrophy.

Tiago Figueiredo, Jeffrey M. Willardson et. al. (2016) conducted a study comparision of the effects of 2 different rest interval lengths between sets and exercises during strength training (ST) on blood pressure (BP) and heart rate variability (HRV) in prehypertensive trained men, and to verify how HRV influences BP. Eleven volunteer subjects (age: 26.1 6 3.6 years; body mass: 74.1 6 7.9 kg; height: 172.1 6 4.1 cm; % body fat: 18.3 6 6.3; ST experience: 1.7 6 0.8 years) participated in this study. After assessing one repetition maximum (1RM) loads for the free weight bench press, lat pull-down, shoulder press, biceps curl, triceps extension, leg press, leg extension, and leg curl exercises; subjects performed 2 sessions with different rest intervals between sets and exercises in random order and 72 hours apart. Each ST session consisted of performing 3 sets of eight to 10 repetitions at 70% of a 1RM for each exercise, with either 1-minute (sequence 1 [SEQ1]) or 2-minute (sequence 2 [SEQ2]) rest intervals between sets and exercises, respectively. Before and after each session, BP and HRV (low frequency band, high

frequency [HF] band, and square root of the mean squared difference of successive RR-interval index) were tracked for 60 minutes. Additionally, increases in cardiac stress were noted after SEQ1, with a greater withdrawal in parasympathetic activity vs. baseline as noted in the HF band at 1-, 10-, and 20-minute postexercise (p # 0.05). These results indicate that both sequences provided an effective stimulus for a PEH. Therefore, strength and conditioning professionals may prescribe 1- or 2-minute rest between sets and exercises when the goal is to reduce BP after training sessions. However, resting 1 minute between sets and exercises was associated with greater cardiac stress, and so this may necessitate prescription of longer rest intervals between sets and exercises when working with individuals who have been diagnosed with cardiovascular dysfunction.

Juha P Ahtiainen 2005 examined Short vs. long rest period between the sets in hypertrophic resistance training: influence on muscle strength, size, and hormonal adaptations in trained men. The experimental design comprised a 6month hypertrophic strength-training period including 2 separate 3-month training periods with the crossover design, a training protocol of short rest (SR, 2 minutes) as compared with long rest (LR, 5 minutes) between the sets. No significant differences were observed between the protocols. Significant increases of 7% in maximal isometric force, 16% in the right leg 1RM, and 4% in the muscle CSA of the quadriceps femoris were observed during the 6-month strength-training period. However, both 3-month training periods performed with either the longer or the shorter rest periods between the sets resulted in similar gains in muscle mass and strength. No statistically significant changes were observed in basal hormone concentrations or in the profiles of acute hormonal responses during the entire 6-month experimental training period. The present study indicated that, within typical hypertrophic strength-training protocols used in the present study, the length of the recovery times between the sets (2 vs. 5 minutes) did not have an influence on the magnitude of acute hormonal and neuromuscular responses or long-term training adaptations in muscle strength and mass in previously strengthtrained men.

CHAPTER III

PROCEDURE/ METHODOLOGY

SELECTION OF THE SUBJECTS

For the purpose of the study, 45 young men will be selected of age ranging from 18-35 years, body mass: 75 ± 13 kg, equally divided into three groups with 10 men in each. There will be two treatment group (group A and group B) and one control group in the study.

SELECTION OF VARIABLE

For the purpose od the study, strength will be measured by modified maximun repetition test, selected blood biomarkers, selected cardiac biomarkers and liver functioning test will be used to observe the effect of different rest interval between rest of resistance training.

ADMINITRATION OF TEST

The tests will be administered to the subjects twice i.e. one before giving the treatment and one after the completion of 8 weeks of treatment. There will be three groups of 15 participants each, every subject will be asked to give reading twice. The subjects will undergo a training regime of 4 weeks/day for 8 weeks. The blood sample extraction will be carried by keeping standardised protocol into consideration.

COLLECTION OF DATA

First Reading: the first reading will be taken before the start of 8 weeks of resistance training in order to measure strength, selected blood and cardiac biomarkers.

Second Reading: the second reading will be taken after finishing 8 weeks of resistance training in order to measure strength, selected blood and cardiac biomarkers.

1st READING
All the variables will be tested before training regime
8 weeks training regime
2nd READING
All the variables will be tested after training regime

EXPECTED OUTCOMES OF THE STUDY

The research will provide a frame to design training regime effectively and without giving any serious physiological concern to individuals. Further, the little understanding about rest interval between sets of resistance training will be addressed thoroughly and training professionals would also consider and recommend different rest periods, allowing enhanced fitness without any negative impact on health.

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